CLAIMS

1. A method of determining a property of a workpiece, the method comprising:

making a first measurement at a first location in the workpiece, employing a first process;

making a second measurement at a second location in the workpiece different from the first location, employing a second process different from the first process; and

combining the first measurement and the second measurement together to determine said property at the second location.

2. The method of Claim 1 wherein said making of second measurement comprises:

illuminating the sample with two monochromatic sources respectively modulated at two corresponding frequencies; and

filtering a reflected signal at the corresponding frequencies to obtain reflectances of the sample at respective wavelengths of the two monochromatic sources.

3. The method of Claim 1 wherein said making of first measurement comprises:

using a spectrometer.

4. The method of Claim 1 wherein said combining comprises:

based on the first measurement, generating, in a computer, a model of the property of the workpiece as a function of a plurality of values of a signal measured in the second measurement; and

based on the second measurement, looking up the model, to determine the property.

5. The method of Claim 1 wherein:

the second location is separated from the first location by a predetermined distance.

6. The method of Claim 5 wherein:

the predetermined distance is sufficiently small to ensure that a plurality of properties, other than said property, are substantially identical between said first location and said second location.

7. The method of Claim 5 wherein:

the predetermined distance is sufficiently small to ensure that a plurality of properties, other than said property, are substantially known at the second location based on the first measurement at the first location.

8. The method of Claim 5 wherein:

each of the first location and the second location lacks a pattern; and

the second location is between the first location and another location that has a pattern.

9. The method of Claim 1 wherein:

the second measurement has a higher resolution than the first measurement.

10. The method of Claim 1 wherein:

the workpiece comprises a semiconductor wafer having a plurality of areas of integrated circuits separated from one another by a plurality of streets; and

the first location is in a street in the plurality of streets, and the second location is in an area in the plurality of areas of integrated circuits.

11. The method of Claim 1 wherein:

the first measurement is made at the first location and over a first area; and

the second measurement is made at the second location and over a second area, the second area having a different dimension than the first area.

12. The method of Claim 11 further comprising:

illuminating the first area with a beam of white light;

illuminating the second area with a beam of monochromatic light, the second area being smaller than the first area; and

making a plurality of first measurements other than said first measurement, at a corresponding plurality of wavelengths.

13. The method of Claim 12 wherein:

illumination with beam of white light is performed by an incandescent bulb; and

illumination with beam of monochromatic light is performed by a laser that is collimated and coherent.

14. The method of Claim 11 further comprising:

illuminating the first area with a beam of white light;

illuminating the second area with a beam of monochromatic light, the second area being smaller than the first area; and

making another first measurement in the second area, with the beam of monochromatic light beam.

15. The method of Claim 1 further comprising:

directing a beam of white light at the first location in the workpiece, wherein said first measurement is one of a plurality of measurements of reflectance at a corresponding plurality of wavelengths; and

directing a laser beam at the second location in the workpiece, wherein said second measurement is of reflectance at a wavelength of the laser beam.

16. The method Claim 1 wherein:

the property changes substantially between the first location and the second location.

17. The method Claim 1 wherein:

the property is of an exposed surface of the workpiece.

18. The method Claim 1 wherein:

the workpiece comprises a wafer including a semiconductor substrate and a plurality of layers formed on the semiconductor substrate;

the first measurement is of reflectance of a dielectric layer in the wafer; and

the second measurement is of reflectance of a topmost layer in the wafer.

19. The method Claim 1 wherein:

the workpiece comprises a wafer including a semiconductor substrate and a plurality of layers formed on the semiconductor substrate;

the first measurement is of reflectance of a metal layer in the wafer; and

the second measurement is also of reflectance of said metal layer.

20. The method of Claim 19 further comprising:

directing a laser pulse to create a sound pulse at the first location, wherein said first measurement is of reflectance of said sound pulse by said workpiece; and

directing a first laser beam and a second laser beam at the second location, the first laser beam having an intensity modulated at a predetermined frequency, wherein said second measurement is of reflectance of the second laser beam at the predetermined frequency.

21. The method Claim 1 wherein:

the workpiece comprises a wafer including a semiconductor substrate and a plurality of layers formed on the semiconductor substrate;

the first measurement is of concentration or concentration profile of dopants in a semiconductor layer in the wafer; and

the second measurement is of junction depth of said semiconductor layer.

22. The method of Claim 21 wherein:

the first measurement is made using a four point probe; and

the second measurement is made using a first laser beam having an intensity modulated at a predetermined frequency, and a second laser beam of a wavelength different from the first laser beam and said second measurement is of reflectance of the second laser beam at the predetermined frequency.

23. A method of manufacturing a workpiece, the method comprising:

polishing a surface of the workpiece;

measuring thickness of a plurality of layers in the workpiece;

based on a plurality of measurements of thickness, generating, in a computer, a model of a plurality of topmost

surfaces of the workpiece as a function of a signal to be measured;

measuring said signal from the workpiece; and

changing a parameter that controls said polishing if a topmost surface of the workpiece, selected from said plurality based on measurement of said signal and said model, has a slope greater than a predetermined value.

24. The method of Claim 23 wherein:

said measuring of thickness is performed in a first location that lacks a pattern; and

said measuring of signal is performed in a second location that is between: the first location, and a third location that has a pattern.

25. The method of Claim 24 wherein:

said workpiece comprises a semiconductor wafer having a plurality of areas of integrated circuits;

the first location is at an edge of an area in the plurality of areas of integrated circuits; and

the second location is in said area.

26. The method of Claim 23 wherein:

said measuring of thickness is based on illumination of the workpiece with a beam of white light; and

said measuring of signal is based on illumination of the wafer with a laser beam.

27. The method of Claim 23 further comprising:

repeating for each workpiece, in a plurality of workpieces being manufactured, each of said polishing, said measurings, and said generating.

28. An apparatus for measuring a property of a workpiece, the apparatus comprising:

a first measurement device capable of measuring said property;

a second measurement device capable of measuring said property; and

an aligner coupled to the first measurement device to position a workpiece for a first measurement at a first location in the workpiece, the aligner being further coupled to the second measurement device to position the workpiece for a second measurement at a second location, the second location having a predetermined relationship with the first location.

29. The apparatus of Claim 28 wherein:

the first measurement device and the second measurement device measure said property at different resolutions.

30. An apparatus for measuring a property of a workpiece, the apparatus comprising:

a first measurement device;

a second measurement device; and

a computer coupled to each of the first measurement device and the second measurement device, the computer comprising software to calibrate the second measurement device for use at a second location in the workpiece based on a plurality of measurements by the first measurement device at a first location in the workpiece, the second location being different from the first location.

31. The apparatus of Claim 30 wherein:

the second measurement device has a higher resolution than the first measurement device.

32. The apparatus of Claim 30 wherein:

the first measurement device comprises a spectroscopic reflectometer; and

the second measurement device comprises a laser reflectometer.

33. The apparatus of Claim 32 wherein:

the laser reflectometer comprises a laser of a predetermined wavelength; and

the software when executed by the computer generates a model of a plurality of topmost surfaces of the workpiece as a function of reflectance at said predetermined wavelength.

34. The apparatus of Claim 28 wherein the software when executed by the computer causes the computer to:

receive a measurement of the workpiece from the first measurement device; and

generate a model of the property of the workpiece as a function of a plurality of values of a signal measured by the second measurement device, based on the measurement from the first measurement device.

35. A method of fabricating a wafer, the method comprising:

forming a portion of a wafer;

making a first measurement in the wafer using a first process;

making a second measurement in the wafer using a second process each time said first measurement is made;

using one of the first measurement and the second measurement to calibrate the other of the first measurement and the second measurement; and

changing a process control parameter used in forming the portion of the wafer depending on the first measurement and on the second measurement.

36. The method of Claim 35 wherein:

said second measurement is used to calibrate said first measurement;

said using comprises:

based on the second measurement, generating a model of a property of the portion of the workpiece as a function of the first measurement; and

looking up the model to determine a value of the property, based on the first measurement.

37. The method of Claim 36 wherein:

said changing of process control parameter is done only if the value of the property exceeds or falls below a predetermined limit.

38. The method of Claim 35 further comprising:

repeating said first measurement and said second measurement in said wafer a plurality of times.

39. A method of determining a property of a wafer, the method comprising:

measuring reflectance of the wafer at a plurality of wavelengths, based on illumination of the wafer with a beam of white light of a first spot size;

based on reflectance at the plurality of wavelengths, generating a model of reflectance at a predetermined wavelength as a function of thickness of a layer of the wafer;

measuring reflectance at the predetermined wavelength, based on illumination of the wafer with a laser beam of a second spot size, the second spot size being smaller than the first spot size; and

based on reflectance at the predetermined wavelength, looking up the model to determine a value of thickness of the layer.

40. The method of Claim 39 wherein:

the layer is hereinafter "first layer," said model is hereinafter "first model," and said value is hereinafter "first value";

the method further comprises determining a second value of thickness of the first layer based on reflectance at the plurality of wavelengths, generating a second model of reflectance at the predetermined wavelength as a function of thickness of a second layer of the wafer and looking up the second model to determine a third value of thickness of the second layer if the first value is greater than the second value by a predetermined amount.

41. The method of Claim 39 wherein:

reflectance at the plurality of wavelengths is measured at a first location;

reflectance at the predetermined wavelength is measured at a second location; and

the second location is separated from the first location by a predetermined distance.

42. The method of Claim 41 wherein:

the predetermined distance is sufficiently small to ensure that a plurality of properties, other than said thickness, are substantially identical between said first location and said second location.

43. The method of Claim 37 wherein:

the predetermined amount is 1%.

44. A method of determining a property of a workpiece, the method comprising:

making a first measurement at a first location in the workpiece;

making a second measurement, at a second location in the workpiece different from the first location, by illuminating the second location with two monochromatic sources respectively modulated at two corresponding frequencies and filtering a reflected signal to obtain reflectances of the sample at respective wavelengths of the two monochromatic sources; and

combining the first measurement and the second measurement together to determine said property at the second location.